Interaction of synchronized dynamics in cortical and subcortical circuits in Parkinson's disease

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Parkinson's disease pathophysiology is marked by increased oscillatory and synchronous activity in the beta frequency band in cortical and basal ganglia circuits. This study explores the functional connections between synchronized dynamics of cortical areas and dynamics of subcortical areas in Parkinson's disease. We simultaneously recorded neuronal units (spikes) and local field potentials (LFP) from subthalamic nucleus (STN), and electroencephalograms (EEGs) from the scalp in parkinsonian patients and analyzed the correlation between the time-courses of the spike-LFP synchronization and inter-electrode EEG synchronization. We found the (non-invasively obtained) time-course of the synchrony strength between EEG electrodes and the (invasively obtained) time-course of the synchrony between spiking unit and LFP in STN to be weakly, but significantly correlated with each other. This correlation is largest for the bilateral motor EEG synchronization followed by bilateral frontal EEG synchronization. Our observations suggest that there may be multiple functional modes by which the cortical and basal ganglia circuits interact with each other in Parkinson's disease: not only synchronization may be observed between some areas in cortex and the basal ganglia, but also synchronization within cortex and within basal ganglia may be related, suggesting potentially more global way of functional interaction. More coherent dynamics in one brain region may modulate or activate the dynamics of another brain region in a more powerful way causing correlations between changes in synchrony strength in both regions.